enerSave
For Municipalities

Energy and Urban Planning

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Contents

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Energy and Urban Planning

Introduction

Through energy-conscious land use planning, the municipal planner can have an important influence on fuel consumption in Canada. This section reviews 26 planning measures which can reduce local energy use. It also takes a brief look at some major barriers facing planners in their attempt to create more energy efficient communities.

1 - Energy and Urban Form

Each of the 26 measures described in this section addresses one or more of the following three key characteristics of urban land use:

- structure and configuration
- density of development
- mix of land uses

Structure and configuration

The overall arrangement of a city and the amount of energy consumed in it are related.[1] It has been shown, for example, that concentric-ring cities consume the most energy, linear cities consume the least, and polynucleated cities fall midway between.[2]

Planners, however, should be cautious in applying these findings since city structures are closely linked to other important factors such as population and employment distribution.[3] As well, the form of a city is largely determined by its history, industry and transportation - factors beyond the planner's control.[4]

Compact, contiguous settlements are more energy efficient than dispersed, sprawling settlements; and land use which houses people near work and shopping is more energy efficient still.[5] This conclusion, however, has to be applied with care in specific instances.

Density of development

Density is a measure of use of a given land area expressed in dwelling units per acre or hectare. Studies show that high density development can reduce energy needs per unit for heating, transportation and other services.[6,7]

Less heat is required because of greater thermal efficiency (in attached units, for instance), smaller unit size,[8] and common heating systems.

Less transportation energy is consumed because distances travelled are shortened. If the development is located on mass transit lines, cars are used less frequently and fewer people own cars.

Services within the development also require less energy because there are fewer and shorter sewer and water mains and fewer street lights.

Finally, per capita energy consumption may also drop.[9] In high-density buildings, for instance, appliances are not used as often, laundry machines are shared and energy consumption for recreation takes place away from the unit.

There appears to be a cutoff point beyond which further increases in density produce more, rather than less, energy consumption, however. Energy requirements for elevators, heating, light and shared facilities increase significantly in buildings over ten storeys. Somewhere beyond that point the energy saving gained by high density can be offset and, in high rises, is probably lost.[10]

Worth noting is that high densities imply, although they don't necessarily involve,

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This section is based on chapter 3, "Options for the Municipal Planner", Energy Conservation and the Municipal Planner, R. Lang and A. Armour, 1980.

changes in building type from detached to multi-unit structures. Because units in high density projects are smaller than detached homes, people accustomed to living in their own houses are often unwilling to move in. Increasing the size of the units is one way to promote high densities, but this reduces the overall energy savings.[11]

Mix of land uses

Mixed land use is more energy efficient than segregated or specialized land use.[12] When community services and housing are available in a single building or compact development, a number of benefits are realized, including:

- lower heating and servicing costs
- fewer automobile trips, since more can be done in one trip
- greater use of public transit
- extended life of buildings
- greater operating efficiency

Opportunities to cut energy costs are particularly promising at nodes and along transit corridors. In neighbourhoods, energy costs can be reduced by providing local convenience stores and other services, mixing residential buildings to accommodate people with different incomes, and giving people housing choices near their jobs. Permitting small businesses to run out of the home also reduces work trips.[13]

Appropriate standards should be set, however, to ensure that the types of activities resulting from such mixed and integrated land use are compatible.

2- 26 Energy-conserving Measures

The 26 energy-conserving measures which follow have been drawn up within five key planning objectives:

- more compact and contiguous urban form
- land use to minimize vehicle trips
- energy-efficient neighbourhoods
- site planning for greater thermal efficiency
- energy-oriented development controls, standards and regulations

Because these objectives span a wide spectrum of community interests they often overlap, and may in fact conflict with other planning objectives. In some cases, they can conflict with each other.

Taken together, however, the 26 measures listed for achieving these objectives indicate broad scope for action by the energy conscious municipal planner. Many measures are complementary, and in practice would be combined. For example, Measure 1 (policies to increase overall densities), Measure 6 (interrelated land use in closer proximity), Measure 7 (development concentrated in nodes and along corridors), and Measure 8 (greater mix and integration of uses) form a logical set dealing with concentrated development.

On the other hand, trade-offs can also exist between two or more energy sensitive measures. Protecting solar access, for example, may require low densities that are in other ways energy wasteful.

The 26 measures included here are among the most commonly used and potentially useful planning tools available for energy-sensitive development. For best effect, however, there must be a firm municipal commitment to make energy conservation a top priority in the planning, development and management of the municipality.

TABLE 1

26 Planning Measures for Energy Conservation

Objective	Measure
A. More compact and contiguous	1. Increase overall densities in urban form municipal plans 2. Encourage infilling and redevelopment 3. Minimize urban sprawl 4. Encourage large-scale integrated development 5. Consider energy implications of major urban infrastructure
B. Land use to minimize vehicle trips	6. Locate interrelated land uses in close proximity 7. Concentrate development in nodes and along transit corridors 8. Encourage greater mix and integration of uses 9. Discourage isolated commercial development 10. Increase local recreational opportunities
C. Energy-efficient neighbourhoods	11. Design local street systems to minimize energy used for transportation 12. Align streets for optimum solar gain 13. Encourage cluster development 14. Provide more neighbourhood services and facilities 15. Provide for district heating and waste heat recovery 16. Encourage multi-unit structures 17. Introduce energy conservation measures into neighbourhood rehabilitation planning
D. Site planning for greater thermal efficiency	18. Orient lots and buildings to profit from natural features 19. Promote energy-efficient building design 20. Encourage landscaping for conservation 21 Protect solar access
E. Energy-oriented development controls, standards and regulations	22. Remove barriers to energy conservation in existing development controls 23. Provide for energy conservation in development regulations and review processes 24. Issue voluntary guidelines for energy-efficient development 25. Provide incentives to developers 26. Require energy impact assessments

Objective A: More compact and contiguous urban form

The five measures grouped under this objective can minimize energy consumption for urban transportation, since urban development policies that emphasize containment over expansion reduce travel requirements. Through creative use of densities, planners can also influence heating needs and encourage use of alternate energy technologies such as waste heat recovery.

Measure 1: Increase overall densities in municipal plans

Many urban policy-makers have not taken into account the effect of development densities on energy consumption. Low-density development poses significant problems.[14] Increasing overall densities slows unnecessary expansion of urban areas and promotes more efficient development, in terms of both energy and economics.

For increased densities, municipal plans can be amended in two ways:

- by incorporating statements concerning higher densities, linked to energy conservation goals, in the overall plan
- by allocating increased densities to certain areas within the development boundary (e.g. Measure 7).

Measure 2: Encourage infilling and redevelopment

Development in outlying areas should be postponed whenever there are options such as infilling vacant land, re-use and recycling of older buildings (e.g. retrofit), and redevelopment of areas of energy-inefficient land use.

Redevelopment/rehabilitation/preservation programs offer opportunities to re-use existing structures or reclaim obsolete areas. Some cities are reducing minimum lot requirements and providing incentives to developers to encourage the use of lots previously ignored because of small size or odd shape.

The energy payoff can be substantial. Planners in Portland, Oregon calculated that reducing lot size to infill 2,000 acres of vacant but usable land within the metropolitan region could achieve a saving of 256 billion BTUs per year by 1995, or 0.4% of their expected 1995 transportation energy requirements.[15]

Measure 3: Minimize urban sprawl

Urban sprawl can be defined in several ways: low-density development on large lots; job concentration at the urban core with population growth at the urban fringe; premature development in outlying areas; "leapfrog" development; a dispersed, discontinuous land use pattern. Sprawl tends to waste energy - from 8% to 14% according to the "Costs of Sprawl" study undertaken by the Real Estate Research Corporation.[16]

Zoning and other land use controls[17] are common growth management techniques to minimize sprawl. Other techniques include annexation, withholding or regulating access to public services, public land banking, and development rights transfer, (i.e. allowing unused development rights for one parcel of land to be transferred to another site within a defined development district).

Measure 4: Encourage large-scale integrated development

Large-scale, integrated projects, including planned unit developments (PUD) or industrial parks, provide a major opportunity to achieve energy efficiency.

A PUD is a housing project of townhouses and/or apartments in which dwellings are grouped into clusters and sited on smaller lots, allowing a sizeable amount of open space to be preserved. Net densities are higher than for conventional projects of similar size, and schools, public facilities, shopping and employment are commonly mixed in with residences.[18]

Compared with sprawl, PUDs, if properly designed, are 45% more economical in terms of energy use.[19] To achieve an energy efficient design, regulations governing lot size, mix and density would have to be relaxed, and a policy statement on the application of the PUD would be needed in the municipal plan. Site plan review guidelines, specifying energy conservation objectives, would be necessary to evaluate PUD proposals.[20]

At present, this approach is possible only in some provinces.

Measure 5: Consider the energy implications of major urban infrastructures

Any major urban infrastructure affects energy consumption. Arterial roads, rapid transit, trunk, water and sewer mains and treatment plants, sports complexes and civic centres - all these facilities require energy to construct, to operate and to maintain, not to mention energy required for capital improvements.

The location, capacity and timing of these "growth-shapers" is also a factor, determining the subsequent location and form of new developments and future travel patterns.[21] Municipal planners can influence all of these energy-related factors.

Planning and budgeting are the keys to minimizing the long-term energy implications of infrastructure development. Plans for public facilities can be designed to prevent "leapfrogging" and to direct development in support of transit systems and integrated jobs and housing.

Effective planning will:

- locate new facilities within developing or developed areas, not on the fringe
- ensure that the new facilities are large enough to accommodate the desired density of development, but not so large that they attract more than intended
- locate major facilities, such as a sports complex, along main transportation routes, especially transit routes
- cluster traffic-generating facilities to form single destination points
- disperse public buildings throughout developing areas to increase the mix of uses
- use capital facilities as tools to assist developers with energy-efficient projects (e.g. include a planned civic auditorium in a development project that emphasizes mixed use and higher density).[22]

The City of Portland, Oregon, is an excellent example of a municipality attempting to influence its future energy consumption through effective planning.

Assisted by a $224,350 grant received from the U.S. Department of Housing and Urban Development in 1975, Portland's planners set out to determine energy consumption patterns, forecast future energy requirements and formulate energy-efficient municipal policies and development plans.[23]

Infrastructure investments became the main focus of the city's development pattern. To ensure that capital improvements were contributing to a more compact city, planners divided the city into five energy zones based on the relative efficiency of energy use within them.

Mapping the city's energy zones served two basic purposes. First, it established priorities to evaluate capital improvements, since public works projects could be assessed for their impact as growth inducers. Priority would be given to those affecting development in high efficiency zones, and withheld where the projects freed up land for development in low efficiency zones. Second, the "energy zones" could be used as a guide in determining what type of development to encourage where. In low efficiency zones, land uses would gradually be converted, through infilling and redevelopment, to a more efficient mix and density.

Objective B: Land use to minimize vehicle trips

The automobile consumes well over half the energy used for transportation in Canada. Compared with buses, trains or airplanes, cars stand out as the most energy intensive way of travelling, using more energy per unit of work than any other transportation mode. In urban areas, this comparison is particularly striking: the automobile consumes nearly five times as many BTUs per passenger-mile as the bus.[24]

Municipal planners can influence trip length, frequency and mode of travel by modifying the land use pattern - the mix, density and intensity of residential, commercial, industrial, recreational and other uses of land.[25] Among numerous measures to reduce automobile use and increase ridership on public transit, the following five stand out.

Measure 6: Locate interrelated land uses in close proximity

Separation of home, workplace and shopping may have doubled energy consumption in

urban areas.[26] Through infilling and redevelopment, this trend can be reversed. Multi-family housing can be located close to the city core, within walking or bicycling distance of work, shopping and public transit. Similarly, new employment centres can be located closer to residential areas and within walking distance of public transit. Finally, major public facilities should be easily accessible by transit.

Planning for Energy Efficient Transportation

- zone for higher overall densities
- promote compact (integrated, mixed, higher density) developments
- integrate employment and residential development with transit;
- zone for mixed use of structures
- allow small, compatible family businesses in residences
- limit number and location of parking spaces
- reduce parking space requirements in multi-occupancy buildings
- locate new public buildings near transit stations
- provide neighbourhood services
- concentrate commercial activities in nodes along transit routes
- encourage multiple and sequential land use along transportation right of way
- provide urban area parks
- provide interconnected bike paths.*

Measure 7: Concentrate development in nodes and along transit corridors

Housing located along transit routes and highway corridors, and high-density developments concentrated into nodes connected to urban centres by public transportation, can result in significant energy savings. Linear or nodal development tends to increase transit use, encourages walking, and results in fewer overall vehicle trips.

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*Adapted from D. Nitkin, "Municipal Planning Opportunities for Energy Conservation in the Transportation Sector", in Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979.

While urban form influences travel behaviours, however, it does not necessarily determine it. People make their own decisions.

Measure 8: Encourage greater mix and integration of uses

Land use policies that reduce car trips have the added benefit of encouraging a greater mix of housing and employment opportunities. Zoning options for this purpose include:

- allowing mixed use within the same building (e.g. family-run businesses in single-family homes)
- mixing different types of residential buildings in a given area (e.g. low-rise apartments and townhouses interspersed with single-family units)
- mixing land uses within a given area.

Mississauga's City Centre Plan, a multi-use large-scale development which integrates municipal offices and commercial and residential uses, offers a good example of this type of development.[27]

Measure 9: Discourage isolated commercial development

Consolidated commercial development encourages one-stop shopping, and reduces car use. City of Portland planners estimated that rezoning scattered strip commercial areas to prohibit new retail outlets (except essential services such as corner grocery stores) would reduce the average number of miles travelled per day by 5%.[28]

Measure 10: Increase local recreational opportunities

Recreation-related travel accounts for a significant proportion of automobile trips. One study suggests that approximately 30% of all non-commercial automobile mileage can be attributed to leisure and recreational use.[29] Other estimates put in-city recreation-related auto use (excluding vacation trips) as high as 20% to 30% of all auto mileage.[30]

A significant amount of energy could be saved by discouraging automobile use for recreation. To justify more attractive local recreational opportunities, however, planners will need detailed information on

the interrelationship between recreational activities, travel and energy use. Once these patterns have been determined, planners can then recommend the design and location of recreation centres, program options and appropriate transportation alternatives.

Objectives C: Energy-efficient neighbourhoods

Opportunities for planners to influence energy needs for transportation and heating are numerous at the neighbourhood and district level. Decisions about density, land use mix and building form here influence efforts to conserve energy further down the line at the site and building levels.

Knowledge about neighbourhood energy planning is growing. A major study by the U.S. Department of Energy (DOE) is now examining the effectiveness of energy conservation at the district/neighbourhood scale, with special emphasis on new towns.

In this study, five projects were selected, and study teams have been given a year to come up with an energy-conserving land use plan. By comparing the new option to a conventional plan for the same site, DOE hopes to quantify the fuel and dollar savings of the energy-conserving plan for each of the sites.[31]

Measure 11: Design local street systems to minimize energy used for transportation

Curved streets, typical of today's suburbs, are energy inefficient compared with a modified east-west grid pattern[32] (see Measure 13) or a modified curvilinear pattern.

Street width can also be a factor in reducing energy consumption. Narrower streets save energy by reducing the amount of petroleum needed in the manufacture of asphalt. They may also decrease automobile use. Reducing the number of through streets discourages automobile traffic and provides a safer pedestrian environment.

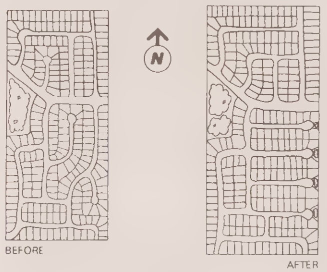
Safety and convenience for pedestrians and cyclists can be further improved by creating walkways and bicycle paths, bicycle lanes on busy streets, links in long blocks and between cul-de-sacs, and secure bicycle parking facilities.

Measure 12: Align streets for optimum solar gain

East-west streets, with southern orientation for lots and buildings, maximize the potential for passive solar heat gain in winter. In areas affected by strong winter winds, exposure to wind is a major factor in building heat loss. Thus street alignment can be critical; depending on local topography, and on the height and spacing of buildings, major roads can channel winds, considerably increasing their velocity.

FIGURE I

STREET ALIGNMENT FOR PASSIVE SOLAR GAIN



Example of a subdivision redesigned to increase the number of lots oriented southward

SOURCE Living Systems, Davis Energy Conservation Report Practical Use of the Sun (Davis, CA City of Davis, 1977) p 35

Measure 13: Encourage cluster development

In cluster development, buildings are arranged in small groups of twenty or more, each similar and forming a design unit. Net density is higher but gross density can remain unchanged. Clustered buildings can also be arranged to shelter each other from wind.

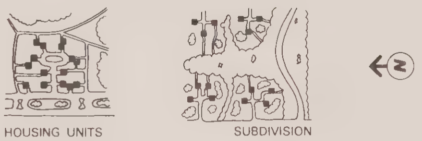
Cluster developments also conserve energy by:

- reducing transportation costs
- reducing costs of providing services such as sewage, water and street lighting
- making centralized heating schemes feasible (see Measures 16 and 31).

To permit cluster development, by-laws regulating yards, setbacks and lot size may have to be relaxed.

FIGURE II

CLUSTER DESIGN



Cluster design trades off reduced lot size in favour of a larger amount of well-designed public or semi public open space

SOURCE Royal Architectural Institute of Canada, Energy Conservation Design Resource Handbook (Ottawa RAIC, 1979) Fig 6 2 3 2-1

Measure 14: Provide more neighbourhood services and facilities

Travel may also be reduced by including stores, recreational facilities, and community services in subdivision developments, redevelopment schemes and infilling projects.

In the City of Portland, for instance, it was estimated that establishing neighbourhood grocery stores at half-mile intersections within residential areas would reduce shopping trip lengths by 25%.[33]

Measure 15: Provide for district heating and waste heat recovery

District heating which provides heating and cooling for a development from one central source can make effective use of waste heat from power plants, garbage and wood waste burning as well as oil, gas or coal. District heating schemes are best suited to new developments ranging in scale from 100 to 2,200 units,[34] where there is also a large heat customer such as a hospital.

Although common in Denmark, Finland and Sweden, district heating schemes have not yet caught on in Canada. So far, district heating has been used only commercially, in cities such as Winnipeg and Toronto.

The following measures can make future district heating schemes more feasible:

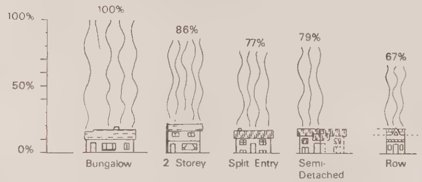
- mixed use, high-density neighbourhoods such as PUDS which offer the necessary economies of scale
- cluster housing projects located close to heat-producing facilities where the land use is compatible with residential development or can be compatible through performance requirements
- incorporation of district heating into PUDS.

Measure 16: Encourage multi-unit structures

Buildings with less wall area exposed to the elements offer significant energy savings. According to one expert, the optimum shape for least transmission heat loss would be a three-storey, square building.[35] The advantages of different shapes in terms of heat loss are shown below.

FIGURE III

RELATIVE HEAT LOSS BY DWELLING TYPE



Heat losses are shown as a percent of heat loss of the bungalow of same habitable floor area

SOURCE Housing and Urban Development Association of Canada, Builders' Guide to Energy Efficiency in New Housing (Toronto, Ont HUDAC and Ontario Ministry of Energy, Jan 1980) p.12

A variety of housing styles in a neighbourhood would allow people with different needs to find accommodation and enable those whose housing needs change during their lives to remain in the same area. In either case, transportation requirements would likely be reduced.

Measure 17: Introduce energy conservation measures into neighbourhood rehabilitation planning

Although the thrust of urban energy-oriented planning is toward new development, rehabilitation of existing neighbourhoods provides the greatest potential for energy conservation. Neighbourhood rehabilitation offers valuable opportunities to upgrade the thermal efficiency of existing houses and to build public support for energy conservation.

Municipal planners can take advantage of rehabilitation programs by providing energy conservation information and assistance to those eligible for neighbourhood rehabilitation grants. Measures to be considered include additional insulation, caulking and weatherstripping, and adding or upgrading storm windows and doors.

Objective D: Site planning for greater thermal efficiency

Proper house orientation, siting and landscaping, along with energy-efficient building design, can produce significant reductions in heating requirements.

Measure 18: Orient lots and buildings to profit from natural features

As far as possible, lots and buildings should be oriented south or near south [37] for maximum solar heat gain. Where lots cannot face south, larger lots provide the flexibility needed to allow proper building orientation. It is important to recognize the trade-offs involved in such instances, however (i.e. between density and solar gain).

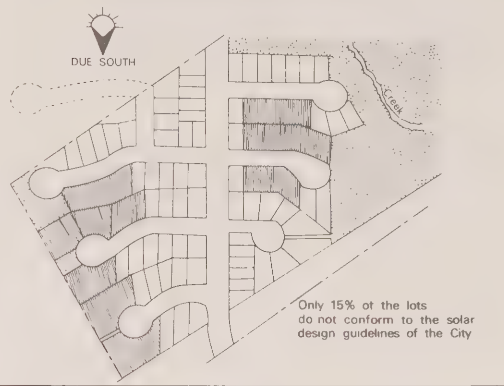
It is still questionable whether Canadian municipalities can legally require lots to be oriented to the sun, even though developers may be persuaded to comply.

Differences in slope on a site can also affect solar access. Sites with slopes facing south and west are preferable to flat sites. To maximize access to the sun where slope varies, high-density multi-family units should be placed on south-facing slopes and lower-density development on east- and west-facing slopes.

The siting of a building on a lot, and its position relative to neighbours, can also reduce the impact of winter winds. Buildings placed perpendicular to prevailing winds receive the full impact of wind, but a building positioned at 45° to the wind results in wind velocity reductions of one half to one third.[38] Wind buffers can be created by placing buildings in parallel rows.

FIGURE IV

SOLAR SUBDIVISION, BRAMPTON, ONTARIO[39]



Alliance Building Corporation is planning a 50-acre, 207-unit subdivision located 1 1/2 miles north of downtown Brampton. It is estimated that innovative subdivision design will save the homeowner an average 10% in energy costs. Tree planting was the only extra cost to the developer.

The key changes include:

- aligning streets east-west so that all lots face south
- designing each unit so that main rooms are located on the south side of the house
- restricting building height to ensure that the shadow of each house falls on an empty space or a street but not on the south wall of another unit
- where necessary, extending the roof overhang to shield south-facing windows from the sun in the summer while allowing full exposure in the winter.

Measure 19: Promote energy-efficient building design

During the site-plan review process, municipal planners should not overlook building shape and placement of windows, two factors which affect thermal efficiency. The greater the exterior surface of a building, the higher the heat loss. Placement and size of windows similarly affect heat loss and gain. Windows on the south side of a building can provide a net heat gain in winter as long as solar access is protected.

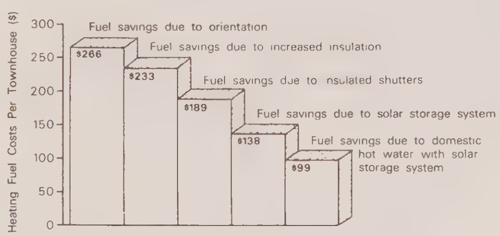
Frankel-Lambert Housing Project, Toronto[40]

Toronto's Non-Profit Housing Corporation has included a number of energy conservation features in a proposed low-rental, low-cost townhouse project (400 units) built on reclaimed industrial land in the City of Toronto.

Houses have been oriented north-south; frontage for the townhouses has been narrowed to 15 feet; insulation levels have been increased (R32-roof, R23-walls and R10-basement); and windows are double-glazed and equipped with shutters.

FIGURE V

ENERGY SAVINGS, FRANKEL-LAMBERT HOUSING PROJECT, TORONTO



SOURCE John Hix, Energy Report, Frankel/Lambert (Toronto City of Toronto, Housing Department, 1977)

Measure 20: Encourage landscaping for energy conservation

Proper landscaping can improve energy conservation in any site plan. Deciduous trees can shade west-facing windows from the summer sun better than roof overhangs, which are not effective against low-angled rays in the late afternoon. In winter, the same trees, leaf-bare, allow south- and west-facing windows full exposure for passive heat gain, while coniferous trees can provide an effective windbreak.

In summer, ground cover can lower surface ground temperatures, thereby reducing the amount of radiant energy likely to be absorbed by the building.

Measure 21: Protect solar access

At the present time, building and property owners have no guarantee that a solar system, active or passive, will have unrestricted access to the sun. To minimize shading conflicts, height and setback of buildings and vegetation must be carefully controlled through zoning, restrictive covenants, dedications of solar easements and site planning.

Some municipalities, such as the City of Brantford, Ontario, require shadow diagrams and "envelope zones" to determine the allowable height and shape for buildings and coniferous trees.

It is unclear whether all Canadian municipalities have the authority required to pass bylaws protecting solar access.

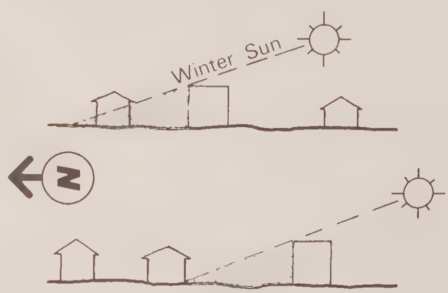
In addition to building and lot orientation, design strategies that can be used to protect solar access include[41]:

- placing taller buildings on the south side of the street

FIGURE VI

STREET WIDTH AS SOLAR ACCESS BUFFER

Placing taller building on the south side of the street and shorter buildings on the north side can help reduce shading.

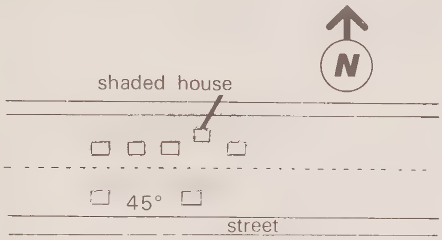


SOURCE: Duncan Erley and Martin Jaffe, Site Planning for Solar Access (Washington, DC: HUD, 1979) p.74

FIGURE VII

UNIFORM VS. STAGGERED SETBACKS

Solar access can be protected by lining up south-facing building walls so that buildings do not shade each other.



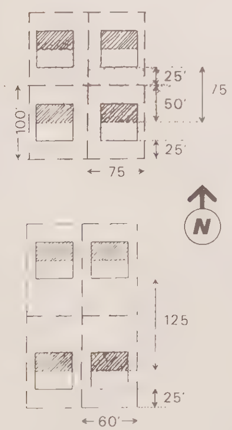
SOURCE: Duncan Erley and Martin Jaffe, Site Planning for Solar Access (Washington, DC: HUD, 1979) p.82

- requiring uniform as opposed to staggered setbacks

FIGURE VIII

REDUCING LOT FRONTAGE

When frontage is reduced from 75' to 60' the plan can accommodate 112' north shadows cast by 28' high buildings.



SOURCE Duncan Erley and Martin Jaffe, Site Planning for Solar Access (Washington, DC HUD, 1979) p 76

- reducing lot frontage while maintaining lot size on east/west streets, resulting in lots that are narrower from east to west and longer from north to south. This applies mainly to single-family dwellings and duplexes.

Objective E: Energy-oriented development controls, standards and regulations

The regulatory process gives municipalities the means to enforce municipal plans and policies. Planners can use regulations to promote energy conservation by:

- applying existing zoning and development controls, making explicit their relationship to energy conservation
- adapting the process of development regulation and review by removing barriers to energy conservation, upgrading thermal standards and adding incentives
- devising new energy-conserving control measures such as energy-oriented site plan review criteria and energy impact assessment.

The following five measures elaborate these options.

Measure 22: Remove barriers to energy conservation in existing development controls

One of the most important steps toward energy-efficient subdivision and site planning would be a review of municipal development controls to identify barriers to innovative design.

For example, building houses either completely or partially underground (i.e. two or three sides buried in a hillside) can be highly energy-efficient due to the insulating property of the earth. Yet this form of development is usually blocked by development controls and building bylaws.[42]

The most common restrictions on energy-conserving development relate to building setbacks, height regulations, fence setbacks and street widths.

Measure 23: Provide for energy conservation development regulations and review processes

Many municipal development controls, standards and planning policies that now guide land use could be used in their present form to achieve energy conservation objectives. This is particularly true for controls affecting density, mixed land use, servicing and landscaping.

Few municipalities, however, have taken advantage of these controls for energy purposes.[43] Fewer still, in either Canada or the United States, have enacted new energy-oriented regulations and review procedures. This step is likely to be taken later as the municipality gains experience in the conservation field.

Municipalities that want to introduce energy considerations into zoning bylaws, subdivision regulations, site plan controls, and development agreements are limited by current planning legislation.[44] Similar restrictions apply to Measure 20, which discusses landscaping requirements for energy conservation purposes.

Measure 24: Issue voluntary guidelines for energy-efficient development

Making developments more energy efficient requires changes in planning, design, construction, operation and maintenance procedures. To this end, guidelines can often be more effective than regulations. Especially in the early stages, voluntary guidelines provide developers with an opportunity to experiment with energy conservation measures and to work out problems. Together with regulatory measures (especially performance standards for energy conservation) the use of guidelines can ease the transition to energy-efficient subdivision and site planning.

Measure 25: Provide incentives to developers

Just as many zoning codes now give bonuses to developers who provide extra open space or recreational facilities, developers who incorporate energy conservation features in their plans could be rewarded.

An interesting incentive offered by the City of Davis, California to energy conserving developers is "priority processing", whereby development plans that comply with the city's guidelines for energy conservation are processed ahead of others.

The power of municipalities to provide incentives to developers depends on whether the incentives involve planning procedures (such as density bonuses which are not uniformly allowed) or fiscal incentives (municipal powers to spend money are controlled under provincial Municipal Acts, and other legislation).

Measure 26: Require energy impact assessments

Like environmental concerns, energy requirements can be identified and incorporated as part of the development design. California is the leader in this approach.

Energy impact reports in California cover:

- Project Description: Energy-consuming equipment and processes to be used in the construction and operation of the project; total energy requirements of the project by fuel type and end use; energy conservation equipment and design features; and initial and life-cycle energy costs of supplies.
- Environmental Setting: Existing energy supplies and energy use patterns available in the region and locally.
- Environmental Impacts: The project's energy requirements; effects of the project on local and regional energy supplies and requirements for additional capacity; effects of the project on peak and base period demands for electricity and other forms of energy; degree to which the project complies with existing energy standards; effect of the project on energy resources.
- Mitigation Measures: Measures to reduce wasteful, inefficient and unnecessary consumption of energy; potential siting, orientation and design to minimize energy consumption; potential for reducing peak-energy demand; alternate fuels or energy systems; recycling potential.
- Alternatives: Options compared in terms of overall energy consumption and in

terms of reducing wasteful, inefficient and unnecessary consumption of energy.

- Unavoidable Adverse Effects: Wasteful, inefficient and unnecessary consumption of energy during the project construction, operation, maintenance and/or removal that cannot be mitigated feasibly.

- Irreversible Commitment of Resources: How the project pre-empts future energy development or future energy conservation.

- Short-term Goals Versus Long-term Impacts: Energy costs over the lifetime of the project.

- Growth-inducing Effects: Estimated energy consumption of growth induced by the project.

The California Energy Commission has prepared an "Energy Impact Handbook" to guide municipalities in energy impact assessment. Contra Costa County has devised a comprehensive set of guidelines for assessing the energy implications of development projects.[45]

3- Barriers To Energy Efficient Planning

As municipal planners adapt energy measures to their local needs, they will face a number of problems. Some of the barriers that planners are likely to encounter include:

- economic barriers
- environmental barriers
- attitudinal barriers
- limited data

Economic barriers

A number of economic factors place constraints on energy conservation and on those who promote it. A prominent example is price. Increased petroleum prices obscure the fact that this energy form remains comparatively cheap because of hidden subsidies. Thus, the costs of energy-efficient processes and products can appear uncompetitive in comparison with existing and traditional energy use, which is geared to inefficiency. Similar biases exist in land use that encourages energy waste, in existing regulations and incentives that encourage such land use,[46] and in the decisions of financial institutions who respond conservatively to the need for energy-efficient development.[47]

Environmental barriers

Although energy and environmental concerns share a similar philosophical base, a potential for conflict exists as well.

For the urban planner concerned with energy use and with environmental quality, certain contradictions can arise. While expressways create noise and air pollution, for instance, it makes sense from an energy conservation point of view to locate people along these routes for easy access to public transit. At a time of increasing building costs, high density projects may also require better soundproofing and good design if the quality of the living environment is to be maintained.

Attitudinal barriers

Opinion polls indicate growing public concern over energy problems. But so far people still dream of the big car and the detached home. These attitudes have serious consequences for planners, since public opinion decides how far energy-oriented plans will go and affects their chances for approval by elected representatives. Public attitudes also shape what the market offers.

Clearly, public resistance to higher densities and cluster development can be a formidable barrier to plans for compact urban forms. Similarly, the fact that people choose where they live, work, shop and play means that the success of land use plans depends heavily on public perceptions of urban realities.

Limited data

Inadequate data[48] on community energy use remains a major barrier to energy efficient land use planning. Accurate, up to date information on existing energy use patterns is virtually non-existent in Canadian municipalities, and elected representatives may be reluctant to commit themselves to tough planning measures when the problems are not clear and their implications are uncertain. They may also be unwilling to give municipal planners a clear mandate to address energy issues.

Footnotes

1. The more prominent studies are reported in: James S. Roberts, Energy, Land Use and Growth Policy: Implications for Metropolitan Washington (Washington, DC: Metropolitan Washington Council of Governments, June 1975); Jerry L. Edwards and Joseph Schofer, Relationships Between Transportation Energy Consumption and Urban Structure: Results of Simulation Studies (Evanston, Ill: Northwestern University, Dept. of Civil Engineering, Jan. 1975); Joseph L. Schofer and R.L. Peskin, The Impacts of Urban Transportation and Land Use Policies on Transportation Energy Consumption (Washington, DC: U.S. Dept. of Transportation April 1977); T. Owen Carroll et al. The Planner's Energy Workbook. A User's Manual for Exploring Land Use and Energy Utilization Relationships (Brookhaven, Sept. 1976); Margaret Fulton Fels and Michael J. Munson, "Energy Thrift in Urban Transportation: Options for the Future", in The Energy Conservation Papers, ed. Robert H. Williams (Cambridge, MA: Ballinger Publishing Co. 1975); Real Estate Research Corporation, The Costs of Sprawl (Washington, DC: Council on Environmental Quality, April 1974).

2. Edwards and Schofer, op. cit.

3. Chibuk, J. Energy and Urban Form (p.5) concludes: "...it would appear that if the population size and distribution can be managed, then the most efficient pattern is one of small to medium sized compact, rectangular or concentric settlements arranged in a polynucleated fashion. However, if population size and distribution cannot be as effectively managed, then the linear pattern or the concentric pattern would be the energy-efficient choice. Contiguous and continuous shapes, under such a condition, are considered to be more energy efficient than discontinuous and dispersed shapes (characterized by sprawl and leapfrogging)".

4. Brian J.L. Berry et al., Land Use, Urban Form and Environmental Quality (Chicago: University of Chicago, Dept. of Geography, 1974) p. 297. This extensive study suggests that core-oriented regions with radial transportation networks have high population densities in the centre, while dispersed urban regions with less focused transport networks have more uniform population densities (the sprawl pattern).

5. Peterson and Keyes, op. cit. p. 22, The authors point out that this conclusion is implicit in the transportation models used to simulate travel behaviour; therefore, such studies should be regarded not as confirmations of the conclusion but as illustrations of the assumed behaviour.

6 Noteworthy are: Priest and Happy, op. cit: Arthur D. Little, Inc., Residential and Commercial Energy Use Patterns, 1970-90 (Washington, DC: Federal Energy Administration (1974); Regional Plan Association and Resources for the Future, Regional Energy Consumption, RPA Bulletin 121, (New York: RPA, Jan. 1974); Hittman Associated, Residential Energy Consumption, Single Family Housing. Final Report (Washington, DC: U.S. Dept. of Housing and Urban Development, Sept. 1975) and Residential Energy Consumption, Multi-family Housing. Final Report (HUD, June 1974); Chibuk, ibid.; Middleton Associates, op. cit; and Peterson and Keyes, op. cit. which includes a concise critical review of the American studies. Harwood, op. cit., provides another review.

7. Exceptions to this conclusion have been noted. See Chibuk, ibid., p. 3-4.

8. Single-family units in Canada, on average, have twice the floor area of apartments (Middleton Associates. Draft Technical Report No. 1, p.5). The Hittman Studies cited in a previous foot note that the size of unit made a substantial difference in total energy consumed per unit; nonetheless, even on a square-foot basis, units in higher-density projects consume less energy than their counterparts in detached units (Peterson and Keys, op. cit.. p. 41), at least in part because households in the latter tend to be larger.

9. Again, there are exceptions. See Middleton Associates, Draft Technical Report No.1, p.77.

10. Peterson and Keyes, Op.cit., p. 43, 47, 65.

11. Ibid., p. 67.

12 Chibuk, ibid., p. 7.

13. See William Toner, Planner for Home Occupations (Chicago: American Planning Association, P.A.S. No. 316, 1976). The City of Davis, California, under City Ordinance 875, allows business enterprises (cottage industries) in residential areas subject to certain criteria - for example, only one non-familial employee may be hired, and no more that 25% of the area of one floor of the residence can be used for the business.

14. D. Nitkin, "Municipal Planning Opportunities for Energy Conservation in the Transportation Sector", in Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979, ed. Fred Curtis (Kingston, Ont.: Queen's University, School of Urban and Regional Planning, 1979), p. 32. See also: Ken Sharratt and Vello Soots, TEMP, Transportation Energy Management Program Aimed at Reducing the Oil Dependence of Ontario Transportation (Toronto: Ministry of Transportation and Communications, Sept. 1979, p. 100-104).

15. City of Portland, Energy Conservation Choices for the City of Portland Volume 3B: Transportation and Land Use Conservation Choices, (Washington, DC: U.S. Department of Housing and Urban Development, June 1977), p. 63, 66.

16. Real Estate Research Corporation, The Costs of Sprawl: Detailed Cost Analysis (Washington DC: Council on Environmental Quality, April 1974), p. 15.

17. For a thorough review of municipal growth management approaches in the U.S. see: Michael E. Gleeson et al. Urban Growth Management Systems: An Evaluation of Policy-Related Research (Chicago: American Planning Association, PAS no. 309 and 310, 1975). A more recent reference is: David R. Godschalk et al., Constitutional Issues of Growth Management (Chicago: American Planning Association, 1979). See also: Bureau of Municipal Research, Legislative Attempts to Control Urban Growth in Canada (Toronto: BMR, 1979).

18. C. Maxwell and J. Huttoon, PUD: A Better Way for the Suburbs (Washington, DC: The Urban Land Institute, 1971), discussed in the Royal Architecture Institute of Canada, Energy Conservation and Design Resource Handbook (Ottawa: RAIC, 1979), Section 6.1.

19. Real Estate Research Corporation, op. cit., Table 69, based on a comparison between a high-density planned community and a low-density planned community both having 10,000 dwelling units.

20. For a discussion of how PUD by-laws can be used to promote energy-efficient land use, see: Corbin Crews Harwood, Using Land to Save Energy (Cambridge, MA: Ballinger Publishing Co., 1977), p. 107-116.

21. Urban Systems Research Engineering, Inc., The Growth Shapers: Land Use Impacts of Infrastructure Investments (Washington, DC: Council on Environmental Quality, 1976).

22. Harwood, op. cit., p. 137, 138.

23. City of Portland, Energy Conservation Choices for the City of Portland Volume 6: Project Overview (Washington, DC: U.S. Dept. of Housing and Urban Development, 1977), p. 71. For further information, contact: Mr. Marion L. Hemphill, Energy Advisor, Policy Development and Research Section, Office of Planning and Development, City of Portland (620 S.W. Fifth Ave., Portland, Oregon 97204).

24. Energy, Mines and Resources Canada, Energy Conservation in Canada: Programs and Perspectives, June 1977, p. 25.

25. W. Curtis Priest and Kenneth M. Happy, An Overview and Critical Evaluation of the Relationship Between Land Use and Energy Conservation. Volumes 1 and 2 (Washington, DC: U.S. Federal Energy Administration, March 1976), p. 93.

26. H. Hendrickson, "Energy Aspects of Urban Planning and Development", Swedish Building Research Summaries, 1975.

27. For further information, contact: Mr. R.G.B. Edmunds, Planning Commissioner, City of Mississauga (1 City Centre Drive, Mississauga, Ontario, L5B 1M2).

28. City of Portland, op. cit., Volume 3B, p. 32

29. Seymour M. Gold, Energy Conservation and Urban Recreation Planning, (Davis, CA: University of California Agricultural and Environmental Sciences 1975), p. 3 (paper presented at the American Institute of Planners Conference, San Antonio, Texas.)

30. Gene Desfor et al., "Patterns of Urban Energy Utilization", in Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979, ed. Fred Curtis (Kingston, Ont.: Queen's University School of Urban and Regional Planning, 1979), p. 2-21; estimate for social and recreational trips in Metropolitan Toronto, 24.2%, Priest and Happy, op. cit., estimate overall social/recreational trips in city at 30%. Metropolitan Dade County Planning Department, Energy Conservation: Proposed Goals and Policies for Urban Development (Miami Fla: The Dept., 1978) estimate for in-city social/recreational trips is 19%.

31. Bill Fulton, "The New Town That Works", APA *Planning*, January 1980. p. 14. See also: *New Ventures in Community Energy Efficiency* (Washington, DC: U.S. Dept. of Energy, Office of Buildings and Community Systems, Office of the Assistant Secretary for Conservation and Solar Energy, 1980) and Reimann Buechner Partnership, *Energy Conserving Site Design Case Study: Radisson, New York* (Washington, DC: U.S. Dept. of Energy, Office of Buildings and Community Systems, Dec. 1979). For further information, contact the Office of Buildings and Community Systems.

32. "In terms of energy efficiency, the curvilinear street pattern, by its very design, predicates against maximizing passive solar gain", says John Hix in *Subdivisions and Sun: 3 Design Studies* (Toronto: Ontario Ministry of Energy, 1979), p. 70. Hix, however, is comparing an unmodified curvilinear plan with a modified east-west grid plan.

33. City of Portland, op. cit., volume 38, p. 32.

34. Royal Architectural Institute of Canada, *Energy Conservation Design Resource Handbook* (Ottawa: RAIC, 1979), Section 6.3. See also: Edward L. Morofsky, "District Energy Options", *Urban Forum*, Vol.3, No. 4, 1977; Energy, Mines and Resources Canada, *District Heating in Small Communities* (Ottawa, EMR, 1977); Ontario Ministry of Energy, *District Heating in Three Nordic Countries - What Can Ontario Learn?* (Toronto: The Ministry, 1978); and W. Bruce Glassford, "District Heating in Canada", *Modern Power and Engineering*, Nov. 1978.

35. K.J. Linton, "Case History, Energy Conservation", *The Canadian Architect*, March 1977, p.45.

36. Sources: Gregg Ross, *Energy Conservation in Land Use Planning* (Brampton, Ont.: City of Brampton, Planning Dept., Feb. 1980), Appendix 4; John Hix, "Energy Conservation: South March Energy Conserving Community, March Township, Ontario", *The Canadian Architect*, Nov. 1978, pp. 42-44; and correspondence from The Planning Commissioner, Regional Municipality of Ottawa-Carleton (22 Queen St., Ottawa, K1P 5V9).

37. John Hix, *Subdivisions and Sun*, p. 67, states (for a site in Ontario, 44°N latitude), "...orientations within 30° of due south lose little winter solar radiation". The estimated amount is 8%.

38. Michael M. Weinstein and Associates, *Energy-Efficient Residential Development, CRAG Region Energy Analysis, Report 3* (Portland, Oregon: Columbia Region Association of Governments, Nov.1 1977). p. 70.

39. Sources: Greg Ross, Energy Conservation in Land Use Planning (Brampton, Ont.: City of Brampton, Planning Dept., Feb. 1980) from which the map in the example is adapted; (Greg Ross, Explanation of Solar Aspects Incorporated into By-Law 139-72 (Brampton, Ont.: City of Brampton, Planning Dept., June 1979); "Owners Play Key Role in Solar Subdivision, Brampton Builder Says", Better Living, Advertising Supplement to the Globe and Mail, September 1979.

40. Source: John Hix, Energy Report: Frankel-Lambert Housing Project (Toronto: City of Toronto, Housing Dept., 1977).

41. The American Planning Association recently prepared two useful reports on solar access: Duncan Erley and Martin Jaffe, Site Planning for Solar Access: A Guidebook for Residential Developers and Site Planners (Washington, DC: U.S. Department of Housing and Urban DEvelopment, 1979) and Protecting Solar Access for Residential Development: A Guidebook for Planning Officials (Washington, DC: U.S. Department of Housing and Urban Development 1979). A third report is forthcoming: Solar Design Review: A Manual on Community Architectural Controls and Solar Energy Use.

42. Kenneth B. Lubs, "Land-Use Regulation of Underground Housing", PAS Memo (American Planning Assiciation), March 1979.

43. A survey of Canadian planners conducted during a study by R. Lang and A. Armour found that only 11 out of 66 municipalities/agencies (17%) were removing barriers to energy conservation in their development controls. Only six (9%) were pursuing energy-efficient development standards. And while 13 (20%) were using solar orientation, only seven (11%) were using landscaping requirements for energy conservation purposes.

44. The situation for Ontario is discussed briefly in Lang and Armour, New Directions in Municipal Energy Conservation, p. 109, 110.

45. A thorough review of Contra Costa's approach to energy impact assessment is provided by Christopher A. Rabenda, "Energy Impact Assessment: What Can Planning Learn from the California Example?" in Considerations and Opportunities for Energy Conservation in Urban and Regional Planning. Conference Proceedings, March 9-11, 1977, ed. Fred Curtis (Kingston, Ontario: Queen's University, School of Urban and Regional Planning, 1979), pp. 9.0 to 9.25. Rabenda has undertaken an in-depth examination of energy impact asssessment for the Ontario Ministry of Energy.

46. This point is discussed in: Corbin Crews Harwood, Using Land to Save Energy (Cambridge, MA: Ballinger Publishing Co., 1977), pp. 29-30.

47. This has been the experience in California where lending institutions, with at least five years of experience with energy-efficient housing units, are only now responding favourably to such development. Their prime concern is that it lacks a ready market. A Catch-22 results when builders of solar houses are unable to secure financing.

48. U. S. Dept. of Energy, Local Government Energy Activities, Volume 1: A Summary Analysis of Twelve Cities and Counties (Washington, DC: DOE, July 1979), p. II-5, II-22 and II-35.